FORESTRY RESEARCH
WHAT'S NEW IN THE WEST

U.S. Department of Agriculture Forest Service

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What's Inside

a note to you

Forestry Research: What's New in the West, is a report on the work of the USDA Forest Service's four Forest and Range Experiment Stations in the West. These research centers, and the States included in their areas of study are: Rocky Mountain (North Dakota, South Dakota, Nebraska, Kansas, Colorado, Arizona, New Mexico, and part of Wyoming, Oklahoma, and Texas); Intermountain (Montana, Idaho, Utah, Nevada, and part of Wyoming); Pacific Northwest (Alaska, Oregon, and Washington); and Pacific Southwest (California, Hawaii, and the Pacific Basin).

on the cover

This is a view of the Saddle Mountain Fire on theBitterroot National Forest in Montana, July, 1960. In this issue you will read about Rocky Mountain Station scientists who are working to develop a system land managers can use nationwide to help make critical fuel management decisions. Also, beginning this year, land managers using the National Fire Danger Rating System will find it updated and improved. Read about this on the facing page.

our addresses

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Retardant drop from a C-130 on a fire in California. Photograph courtesy of Boise Interagency Fire Center.

An updated National Fire-Danger Rating System

Thirty years ago, Harry T. Gisborne, a noted pioneer in fire research, said to a gathering of land managers, "I doubt that anyone will ever be able to sit down to a machine, punch a key for every factor of the situation, and have the machine tell him what to do."

But Gisborne himself had already sown the seeds for a system to rate fire danger. In 1932, a milestone in fire research was reached when Gisborne put together his first trial fire danger meter. The device rated the effect of each of six factors in fire danger—season, wind, visibility, humidity, fuel moisture, and lightning and human activity.

Further research by Gisborne and others led to numerous fire-danger rating systems in the United States. By 1954, eight different systems were being used.

In 1958, the Division of Fire Research of the Forest Service began a development program for one fire-danger rating system that could be used by all fire managers in the United States. By 1965, most State and Federal fire management agencies were using the first index—the spread index—in some form.

A second program was begun in1968 at the Rocky Mountain Station to produce a complete system that would include probability of ignition, evaluations of risk, rate of spread, and the rate of energy release.

The first National Fire-Danger Rating System was released in 1972. It began as a manual system, using tables to compute the indexes and components. Early in 1975 a computer program AFFIRMS (Administrative Forest Fire Information Retrieval Management System) was available for general use. By the spring of 1977, the NFDRS was being used by all Federal agencies and 38 State agencies charged with forest and rangeland fire protection.

Even as the 1972 System was released for field use, knowledge of combustion physics, wildland fuels, and the factors that influence the occurrence of forest and rangeland fires was expanding. Plans were made to update the System.

In 1974, Chief John R. McGuire established a technical committee of Forest Service research and forest systems personnel, and fire managers of the Bureau of Land Management and the States of Pennsylvania, North Carolina, and Oregon to direct the program.

Thus began the cooperative effort that channeled information from the Rocky Mountain and North Central Stations to the Intermountain Station's NFDRS research work unit at Missoula. Project Leader John Deeming views the unit as a "synthesizer" of information. He says, "The system couldn't have been developed by one research group. The contributions from Rocky Mountain, North Central, and other research work units of the Intermountain Station have enabled us to provide field users with the best possible fire-danger rating system."

Improvements in the System

Beginning in 1978, land managers using the System will find it updated and improved. The most significant of the changes are:

Fuel models.—The set of fuel models has been increased from 9 to 20, and should adequately represent the fuels that must be dealt with throughout the country. The models, grouped according to the climates where they are most likely to apply, represent grass, brush, timber, and slash types.

Drought.—The 1972 rating indexes did not reflect the effects of long periods of below-normal precipitation. To correct this, the researchers turned to the computer and fuel models to determine how long-term drying of fuels affects fire behavior. To make the models more responsive to drought, they have added live fuels and 1,000-hour timelag fuels where warranted.

Rating sensitivity.—The limited sensitivity of the 1972 NFDRS was a concern to many users. Because of the finite 0-100 scale for the ratings, fire managers in the relatively moderate fire climates of the country rarely saw ratings greater than 8 or 10.

This problem has been solved by making the scales open-ended, which will result in a three- to fivefold increase in sensitivity of the burning index and a doubling of the sensitivity of the spread component.

Changing day length.—The 1972 System tends to overrate fire danger during the early spring, late summer, and fall, particularly in Alaska and along the northern tier of the lower 48 States. The 1978 version reflects the effect of changing day length on burning conditions. As the period of daylight shortens, nighttime conditions are given increasing weight, thus promoting recovery in the predicted moisture content of the heavy fuels.

Occurrence indexes.—The 1978 NFDRS separates the occurrence indexes for man-caused and lightning-caused fires.

Procedures for estimating man-caused risk are similar to those used in the 1972 NFDRS. However, incorporation of a statistic derived from local records of fire weather and man-caused fires has greatly increased the accuracy of fire occurrence prediction.

The lightning-caused fire occurrence index will predict the expected number of lightning-caused fires on a rating area. It incorporates locally derived statistics of fire and thunderstorm occurrence, as well as a physical model that relates the production of lightning and precipitation to thunderstorm characteristics.

Fuel moisture.—One of the more important changes introduced in the 1978 NFDRS is a method to predict seasonal changes in moisture content of annual and perennial herbs and grasses, and the foliage and small twigs of shrubs. In the System, the user has considerable control over the responses of the live fuel moisture models through his selection of climate class and the type of lesser vegetation—annual or perennial.

The updated System is documented in "The National Fire-Danger Rating System—1978," GTR-INT-39-FR14. Authors are John E. Deeming, Robert E. Burgan, and Jack D.

Cohen. The publication includes basic instructions for applying and interpreting the System. A companion publication, "Manually Calculating Fire-Danger Ratings—1978 National Fire-Danger Rating System," GTR-INT-40-FR14, is intended for those who do not use the AFFIRMS computer program. Authors are Burgan, Cohen, and Deeming.

Eleven regional teams composed of representatives of the Forest Service, Department of the Interior, and State agencies are currently conducting training sessions on use of the new System.

Helicopter sling loading equipment to a spike Camp. Photograph courtesy of Boise Interagency Fire Center.

Land managers like Dale Thompson, a member of the Intermountain Region training team, are pleased with the improvements in the 1978 NFDRS. Thompson says the new System will enable them to do a better job of planning. "We in Region 4 especially like the emphasis on drought."

Deeming, Burgan, and Cohen will continue to evaluate the effectiveness of the System. They are currently working with the Pacific Southwest Station and the State of Hawaii to adapt the System for use in Hawaii. The tropical environment and local management needs require special considerations.

Fire-danger ratings enter into many decisions routinely made by the fire manager. In presuppression, they are used to determine the level of preparedness, the location of suppression forces, and detection strategy. As a suppression tool, they provide guidance in selecting an appropriate initial attack strategy. In the very important area of prevention, actions such as issuance of public warning, regulation of public and industrial activities, initiation of forest closures, and fielding prevention patrolmen can be keyed to fire-danger ratings.

During an average year, 120,000 wildland fires burn 3 million acres in the United States. The resource value destroyed is about $200 million, and loss in terms of national products approaches $1 billion. Federal and State fire control agency expenditures exceed $150 million. Reduced damage and suppression expenditures can be expected with a more sensitive and reliable fire-danger rating system.

During the summer of 1977, data from more than 1,050 fire weather stations and 35 fire weather forecast offices throughout the country were processed through AFFIRMS, and half again as much data were processed manually each day. Fire-danger rating has approached a level of sophistication beyond Gisborne's greatest hopes.

—by Delpha Noble,
Intermountain Station

What will be the potential for large wildfires here if: (1) the slash were left on top of accumulations of natural fuels? (2) slash were thoroughly cleaned up? (3) natural fuels were burned before harvesting created activity fuels?

Fuel management — Will it pay?

Techniques for controlling wildfires are becoming increasingly efficient. But the resources destroyed by fires, particularly the big ones that get away, far exceed the level agencies and private land owners can afford. Part of the explanation for these losses lies in the growing amount of fuel in many of our forests. Why are fuel loads increasing?

First, our efficiency has reduced the role natural fires play in cleaning the accumulated remains of dead plants from our forests. Even green plants are contibuting to the fuel load in areas where dense growth occurs without the thinning effects of fire, or some type of forest management practice.

Second, environmental pressures have imposed greater use of partial harvesting systems, such as shelterwood or selection, on forest managers. These practices affect more acres than clearcutting for the same timber yield, and they generate fuel which is difficult and expensive to clean up.

Consequently, land managers are asking, "Which will cost more — controlling fuel buildup or accepting the losses that will result from wildfire?"

As a result, the volume of both "activity fuels," created by timber harvest and stand improvement, and "natural fuels" has increased dramatically in many areas. One way to alleviate this situation is direct fuel control. But that costs money! The Forest Service alone spends $33 million a year on fuel management and costs are rising.

This is where the National Fuel Inventory and Appraisal Research Project enters the picture. Established in 1976 at the Rocky Mountain Station in Fort Collins, Colorado, the Project is charged with developing a system land managers can use nationwide to help make critical fuel management decisions.

Project Leader Stan Hirsch says, "The objective of our research team is to devise a system that will enable managers to predict resource losses under various fuel management options while considering the probable occurrence of wildfire, potential fuel loads, weather conditions, and suppression capabilities. Our initial emphasis will be on 'activity fuels' followed by a 'natural fuels' procedure. The National Forest System and the Bureau of Land Management are both represented on the team to insure that the final product meets user needs."

"We don't intend to re-invent the wheel," Stan points out. "Rather, we're drawing together a number of excellent fuel assessment techniques, fire spread models, and data libraries that have already been developed and tested. We are modifying these tools and linking them together in one operational system that can readily be used by fire management specialists on the ground."

Most of the techniques and models Stan refers to are recent products of the Intermountain Station's Northern Fire Laboratory at Missoula, Montana. They include ways to: inventory dead wood on the forest floor before timber harvest; predict slash accumulations resulting from alternative harvesting programs; predict the rate of spread, flame length, and heat intensity for fires in various fuel types; and predict how high live trees will be scorched.

The data libraries Stan talks about are housed at the Department of Agriculture's Fort Collins Computer Center. They include the National Fire Weather Data Library, which contains fire weather information collected by numerous agencies across the nation, and the 5100-29 Fire Report Files which describe past fires.

Using the System

For a look at how the "activity fuels" system is developing, let's examine a recent study on the Coconino National Forest in Arizona. Two timber sales are scheduled for a 12,000-acre watershed. Planners are concerned with all resource values in the area and hope to maintain a wildfire level that will be compatible with these values.

Prior to the turn of the century, natural fire reduced fuel on the forest floor and thinned dense reproduction every 7 years or so. Protection, however, has allowed the fuel load to increase significantly in recent times. Dense clumps of reproduction are scattered throughout the area. The concern is that cutting will add to the already heavy fuel load. Some kind of fuel modification will probably be required.

Turning to the Fire Report Files, Project scientists learned that the Coconino experiences 2.7 fires per 10,000 acres annually. They also found that 99 percent of all fires are controlled at less than 10 acres. Those that escape, however, end up burning 400 acres on the average!

Next the scientists asked experienced fire personnel what the most important factor was in the spread of those fires that exceeded 10 acres. The answer was "spotting" — fires reaching dense patches of saplings, jumping to the tree crowns, and throwing firebrands 1/8 mile or more. Often these patches contained old logs — called "jackpots" — which transported fire from the forest floor to lower crown branches.

Spotting happens when the moisture content of small fuels — under 1 inch in diameter — is less than 10 percent and winds exceed 10 miles per hour. With the help of the FIREDAT Library, the researchers found that these conditions are present 43 percent of the time that fires occur.

Next, questions were formulated about events and conditions leading to spotting

situations. Answers were provided by library data and fuel assessments in the form of "yes" or "no", or specific numbers describing on-the-ground conditions. These answers provided the "real world" inputs needed to drive the models.

The models then produced a sequence of probability statements that answered questions such as: "What are the chances of fire occurring when moisture and wind conditions are right for spotting? When are fuel accumulations right for spotting? When can the fire burn hot enough to spot?" And finally, "What are the chances that a fire will exceed 10 acres in size?" This type of analysis was carried out for three proposed fuel management approaches. See figure 1.

Fuel concentrations, or jackpots, can carry fire from the forest floor into tree crowns. Spot fires may result when firebrands are lofted from the burning crowns into the surrounding forest.

Approach A calls for thorough cleanup by piling and burning all slash immediately after harvest. Essentially, this approach maintains fuel buildup at preharvest levels.

Approach B uses prescribed fire prior to harvest to reduce existing litter and "jackpots."

Approach C calls for all slash to be dropped on existing litter and "jackpots" with no cleanup.

Under approach A, the chances are less than one in a hundred that a fire will exceed 10 acres in any year. If approach B is used, the potential increases to 5 percent. If approach C is followed, the potential jumps 25 times — to 11 percent — the first year after harvest. As the slash deteriorates with time, the potential for large fires declines.

So, what kind of losses can be expected? The management plan calls for a 120-year rotation, with harvest cuts to be made very 20 years. The initial cut will be the heaviest and create the greatest fuel load.

Multiplying the average number of fires expected per year (3.2 for the 12,000 acres) by the potential for fires to exceed 10 acres (the percent for each fuel treatment approach), and the average acreage lost to fires that exceed 10 acres (400), the scientists came up with a prediction for the number of acres wildfire might be expected to burn during the first 20-year cutting cycle. The results are shown in figure 2.

If prescribed fire is applied before harvest, the acreage burned by wildfire in the 20 years thereafter will probably double compared to preharvest or complete slash cleanup conditions. If no pre- or postharvest fuel cleanup is done, the potential loss increases sixfold.

What does this boil down to as far as costs and benefits? In this study, the scientists looked only at timber values during the first 20 years of the planned rotation. But similar analyses could be made for other resources, and for longer periods, if needed.

To assess alternatives, the researchers applied the three basic fuel treatment approaches to five management options. Using a 7½ percent discount rate, they calculated the present value of the 1st and 20th year harvests and the present value of

FIGURE 1

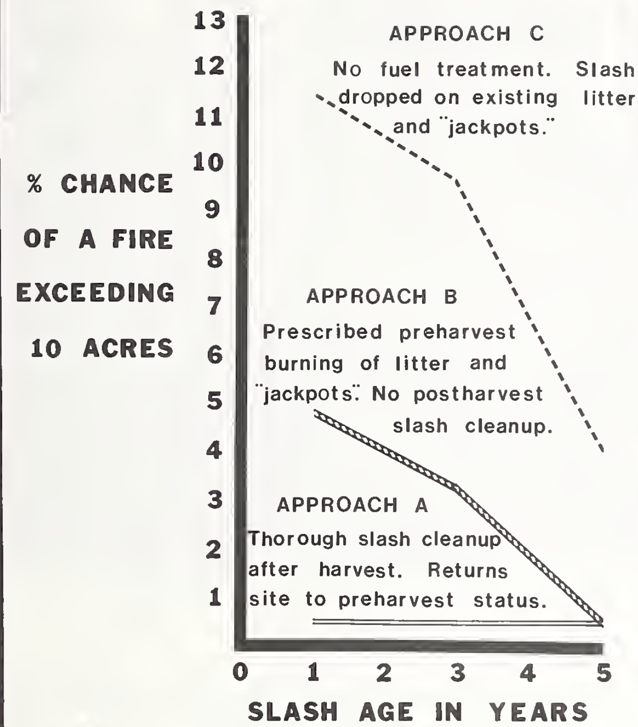
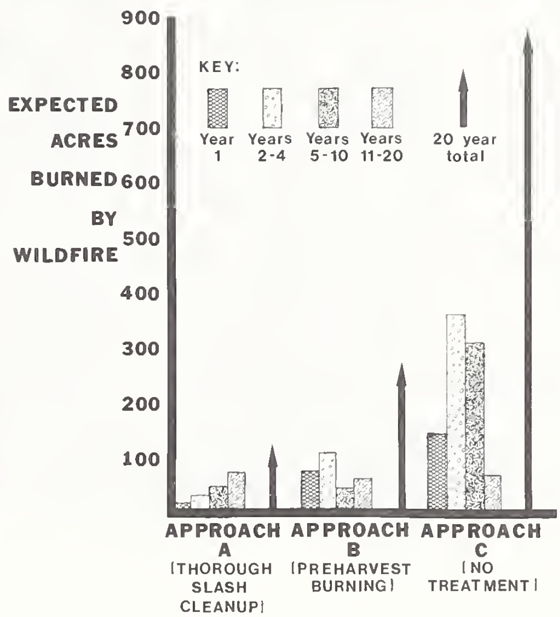


FIGURE 2



the wood resource that might be lost as well as fuel treatment and fire suppression costs for the 20 year period. Subtracting projected costs and losses from potential revenue produced the present net worth for each option. Figure 3 shows the results.

FIGURE 3

Management Option	*20 Year Present Net Worth for Timber (millions of dollars)	Expected % of Area Burned by Wildfire in 20 Years
1 Optimum silviculture, no fuel treatment.	7.69	7.3
2 Optimum silviculture, complete slash cleanup.	7.02	1.0
3 Optimum silviculture, preharvest burning.	6.79	2.3
4 Modified silviculture, preharvest burning, mechanical precommercial thinning.	7.05	2.3
5 Modified silviculture, preharvest burning, precommercial thinning by burning.	7.17	2.3

*7.5 percent discount rate applied to all future values and costs.

The Options

Option 1 proposes that the best silvicultural treatment — a mix of sawtimber harvest, pole thinning for pulpwood, and precommercial thinning — be applied. But, no pre- or postharvest fuel treatment would occur. This option, as well as option 2, would yield the highest initial timber values. Option 1 would also generate the highest future fire suppression costs and timber losses. Wildfires with enough intensity to cause severe damage could burn more than 7 percent of the area each 20 years — nearly 43 percent of the entire watershed during the 120-year rotation.

Option 2 proposes the same silvicultural treatment as option 1, with thorough slash piling and burning to follow each harvest.

Prescribed fire before harvesting can help reduce the buildup of down fuels and the potential for large wildfires after harvest.

This option should hold the annual acreage burned by wildfires to the preharvest level, about 1 percent. But fuel cleanup costs would reduce the present net worth of the stand $670,000 below that of option 1.

Option 3 proposes that litter and "jackpots" be burned by prescribed fire prior to harvest. Because of scorching, pole-size trees would not be saleable for pulp. They would, however, be mechanically thinned to improve future sawtimber values. Because of the high cost of thinning the pole stands, the present net worth of this option would be $900,000 below option 1. Less than 3 percent of the watershed would probably be burned by wildfire during each 20 year cutting cycle — 14 percent for the entire rotation.

Options 4 and 5 would be less desirable from a silvicultural point of view. Pole-size stands would not be thinned at all, diminishing future timber volumes and values. Fuels would be treated by preharvest burning. Precommercial thinning for option 4 would be done mechanically; for option 5 through more intense prescribed burning. Potential losses to wildfire would be the same as for option 3. The present net worth for options 4 and 5 would be $640,000 and $520,000 less than for option 1. These differences may be offset to a degree by grazing, wildlife, water, and esthetic values.

Stan says the evaluation developed for the Coconino test area is representative of the type of information the National Fuel Inventory and Appraisal System should produce. This kind of information will help managers assess the potential impacts of alternative approaches to fuel treatment and select those that will best serve overall management objectives.

Several more tests are planned in different fuel types to find out if the System is versatile enough for operational use on a nationwide basis. The portion for "activity fuels" should be ready in late 1979, and the one for "natural fuels" in 1981. Training packages will be developed to teach field personnel how to use the fuel inventory techniques, the fire spread models, the data libraries, and the analytical procedures that make up the System.

—by Phil Johnson,
Rocky Mountain Station

New aid developed for analyzing tree hazard

Some 12 years ago, Dr. Lee A. Paine, a forest pathologist at the Pacific Southwest Station, developed a form for reporting on tree failures in forested recreation sites. Since then, he has received almost 18,000 of these reports from land managers throughout the United States.

The reports include such a mass of information that Paine developed a data-management system to store and retrieve data and to provide for computer analyses of the relationships between tree characteristics, environmental factors, and anticipated hazards. He has now refined this personal research tool and made it available for use by forest managers to evaluate problems posed by hazardous trees on forest and urban recreation sites, campgrounds, and other areas that receive high public use.

Each year, tree failures injure or kill people and damage property in forest recreation areas throughout the country.

Each year, tree failures kill or injure people and damage property in forest recreation areas throughout the country. These accidents have been increasing in proportion to the rising intensity of public use of forest lands, and the costs per accident have been increasing even more rapidly.

An acknowledged pioneer in research on hazard control in public recreation areas, Paine conducted some of the first studies to these data systematically, he developed the tree failure report—a simple, standardized checklist (Forest Service Form PSW-4600-3) that covers the major factors contributing to tree failure.

Reports submitted on this form provide the data base. With the group of computer programs now available, a land manager can accurately monitor conditions on a specific site over a period of time. The programs will

Defects, such as lean, and the probability that a site will be occupied, can increase a tree's hazard rating, under the tree rating system developed at the PSW Station.

define the factors involved in accident hazards associated with trees and to provide a practical method for hazard evaluation. He also developed procedures and recommendations for establishing administrative goals and safety standards that would provide an acceptable level of safety for forest visitors.

In both of these phases of his nationwide studies, Paine has relied on data supplied by numerous public agencies. To help handle

produce an array of tables to help managers pinpoint high-risk campgrounds, picnic areas, or trails; learn the weather and site conditions that precipitate failure in certain tree species; and relate defects, such as rot, fire wounds, or disease cankers, to failure frequencies.

When data is recorded on the standardized form, the checklist categories serve as subject headings for the computerized analyses. For example, the form provides for five

classes of failure—upper bole, lower bole, butt, limb, and root system. A query to the computer will show how many failures injured people or damaged property, and what costs were involved. Failures can be related to tree species, defects contributing to the failure, triggering environmental factors, tree diameter, tree age, elevation of the site, time of day and year in which the failure occurred, and most of the other information that is supplied on the tree failure reports. In all, the programs will display data in seven different groups of tables, each with different coordinates.

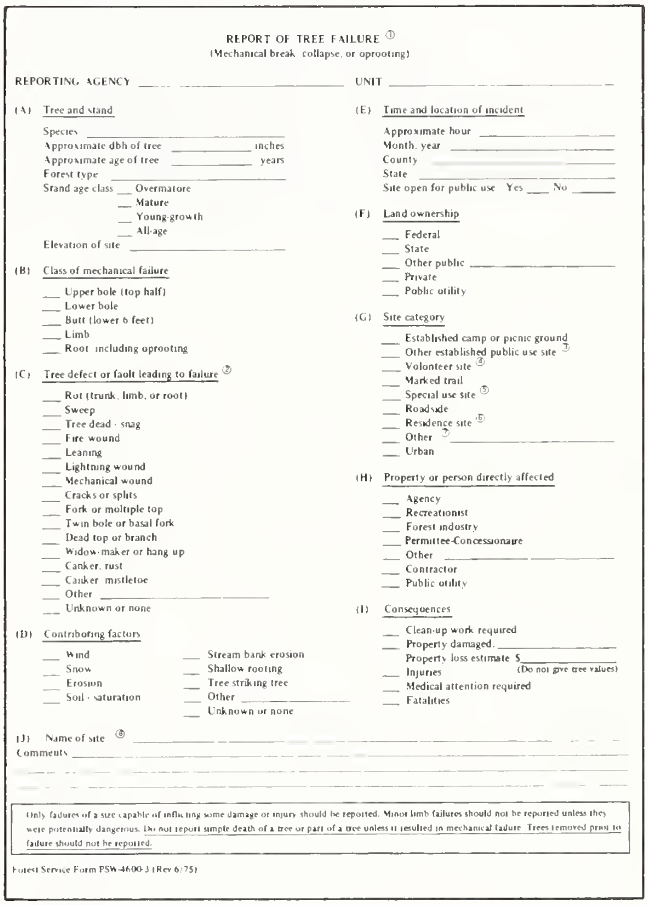
The programs

To obtain these analyses, data from the tree-failure reports are coded and keypunched into computer-readable format. The first of the programs, ERROR CHECK, alerts users to certain types of errors that may have been introduced during coding. This is followed by WRITE, in which new data can be added to any earlier data already on tape. The third program, FAILURE, produces the tabular analyses. Here, the user has a lot of leeway in specifying the range of data to be analyzed. For example, if the manager is concerned about the hazards presented by old-growth lodgepole pine in campgrounds during the summer months, the computer can be instructed to select reports of failures that meet these specifications. Some 28 characteristics, or "selectors," may be specified, singly or in combination.

The final program, PUNCH, provides options for segregating subsets of data for further analysis, which saves computer time and expense when only a small set of data needs to be analyzed.

Although the programs were developed for Paine's national analyses, they are equally useful for analyses of regional or area trends. They will help managers reevaluate current programs for controlling hazardous trees to ensure that situations presenting the biggest problems are receiving the most attention. They are an aid in selecting new recreation sites, by showing hazards that should be avoided, and are also useful in providing detailed records if legal action is brought against an agency because of a tree-failure accident.

The historic data base and the new programs have been used to supply information and specific analyses to most Regions of the National Forest System; the Bureau of Land Management; Yosemite, Sequoia-Kings Canyon, and Yellowstone National Parks; the California State Department of Parks and Recreation; Washington State Parks and Recreation Commission; and many other state, county, and city agencies involved in management of forest and urban recreation lands.



REPORT OF TREE FAILURE ①
(Mechanical break, collapse, or uprooting)

REPORTING AGENCY ____________ UNIT ____________

(A) Tree and stand
Species ____________
Approximate dbh of tree ________ inches
Approximate age of tree ________ years
Forest type ____________
Stand age class ___ Overmature
___ Mature
___ Young-growth
___ All-age
Elevation of site ____________

(B) Class of mechanical failure
___ Upper bole (top half)
___ Lower bole
___ Butt (lower 6 feet)
___ Limb
___ Root including uprooting

(C) Tree defect or fault leading to failure ②
___ Rot (trunk, limb, or root)
___ Sweep
___ Tree dead - snag
___ Fire wound
___ Leaning
___ Lightning wound
___ Mechanical wound
___ Cracks or splits
___ Fork or multiple top
___ Twin bole or basal fork
___ Dead top or branch
___ Widow-maker or hang up
___ Canker, rust
___ Canker mistletoe
___ Other ____________
___ Unknown or none

(D) Contributing factors
___ Wind
___ Snow
___ Erosion
___ Soil - saturation
___ Stream bank erosion
___ Shallow rooting
___ Tree striking tree
___ Other ____________
___ Unknown or none

(E) Time and location of incident
Approximate hour ____________
Month, year ____________
County ____________
State ____________
Site open for public use Yes ___ No ___

(F) Land ownership
___ Federal
___ State
___ Other public ____________
___ Private
___ Public utility

(G) Site category
___ Established camp or picnic ground
___ Other established public use site ③
___ Volunteer site ④
___ Marked trail
___ Special use site ⑤
___ Roadside
___ Residence site ⑥
___ Other ⑦ ____________
___ Urban

(H) Property or person directly affected
___ Agency
___ Recreationist
___ Forest industry
___ Permittee-Concessionaire
___ Other ____________
___ Contractor
___ Public utility

(I) Consequences
___ Clean-up work required
___ Property damaged. ____________
Property loss estimate $________
(Do not give tree values)
___ Injuries
___ Medical attention required
___ Fatalities

(J) Name of site ⑧ ____________
Comments ____________

Only failures of a size capable of inflicting some damage or injury should be reported. Minor limb failures should not be reported unless they were potentially dangerous. Do not report simple death of a tree or part of a tree unless it resulted in mechanical failure. Trees removed prior to failure should not be reported.

Forest Service Form PSW-4600-3 (Rev 6/75)

The Tree Failure Report form provides a simple, straightforward record of tree failures; computer analyses of data from these forms can indicate problem species, identify high-hazard sites, and show important interrelationships between species, sites, tree defects, and environmental conditions contributing to tree failures.

Not every tree failure can be prevented, but a systematic approach to hazard control can keep failures to an acceptable minimum.

Generally, time limitations have forced Paine to limit analysis service to cooperating agencies. With copies of the new programs, however, he says any administrator or manager with access to a large computer can carry out his own analysis.

Publications

A publication entitled "Tree Failures and Accidents in Recreation Areas: A Guide to Data Management for Hazard Control," General Technical Report PSW-24-FR14, by Lee A. Paine and James W. Clarke, is available from the Pacific Southwest Station. Programs and a coding manual are also available as printouts or on magnetic tape. Paine suggests persons interested in the programs contact him at the address or phone number listed below. "If we know in general what the major problems or objectives are, we will be able to supply the most pertinent materials," Paine says.

The data management system is the most recent product of Paine's research on hazardous trees. The two publications describing his hazard-rating system and the procedures for establishing safety standards have gained wide acceptance.

In Research Paper PSW-68-FR14, "Accident Hazard Evaluation and Control Decisions on Forested Recreation Sites," Paine presents a procedure for a consistent, realistic estimate of hazard and outlines a field guide that can be used to assign numerical ratings to hazardous situations involving trees, forest visitors, and fixed property. A 10-step procedure is used to determine if the numerical hazard rating exceeds the desired control level, in which case corrective or remedial action is indicated.

In a follow-up publication, "Administrative Goals and Safety Standards for Hazard Control on Forested Recreation Sites," Paine presents guidelines and calculations for using tree-failure reports and the hazard-rating system to establish safety standards designed to achieve specific goals. The calculations are based on accident rates in relation to millions of visitor-days. The procedures outlined show how the standards can be updated to meet projected increases in acreage involved or in numbers of forest visitors. The report is Research Paper PSW-88-FR14.

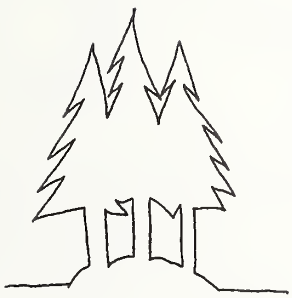
According to Paine, the concepts outlined in these publications have been made even more useful with the acquisition of data on some 18,000 tree-failure reports and their incorporation in the new data-management system.

"Today," Paine says, "we have enough data on tree failures to permit most individual agencies to control hazard with predictable results and at lower costs."

Copies of the publications are available from the Publications Section, Pacific Southwest Station, P.O. Box 245, Berkeley, CA 94701. Information on the computer printouts and tapes can be obtained by writing Paine or by phoning him at (415) 486-3158 or FTS: 449-3158.

—By Marcia Wood,
Pacific Southwest Station

Estimating log weight for aerial yarding



A practical method for estimating the weight of logs before they are yarded from the woods has been developed by researchers at the Pacific Northwest Station's forest engineering research unit in Seattle. The new method helps solve a long-recognized problem—how to load cable and helicopter yarding systems efficiently up to weight limits without overloading. A round, 4-inch, plastic slide rule that incorporates the essential tables and ratios makes the new method easy to use. With the slide rule, workers who load weight-sensitive equipment can quickly determine either the best bucking length for large diameter logs or the number of smaller diameter logs that can be combined to make a capacity load.

The new method estimates log weight by multiplying cubic volume by weight per volume. The technique was developed by forest engineers Charles Mann and Hilton Lysons after a study of variations in log weight at the University of Washington found that cubic volume is a better indicator of log weight than board foot volume.

Mann and Lysons calculate cubic volume from log length, large end diameter outside bark, and assumed taper. In practice, the user does not have to worry about cubic volume; a formula for this is built into the slide rule. But the user must determine the weight per volume (density index) for the species being logged at the specific location. This is found by weighing and measuring sample logs, usually by the truckload. Once the density index is determined, the user needs only the large end diameter—and the slide rule—to find either scaling length or weight.

The weight estimates using this method are much more accurate than the usual rule of thumb, according to Lysons. As aerial logging systems with critical weight limitations have come into wider use, the need for

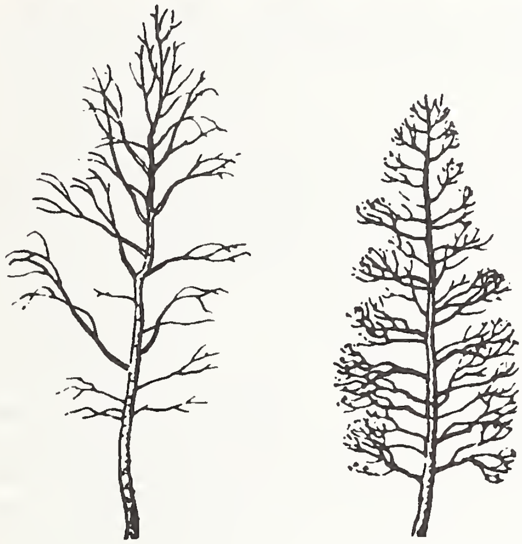
practical method of estimating log weight has accelerated.

There has already been a good deal of interest in the method. When 200 sample slide rules were made available by Mann and Lysons, the supply was soon exhausted. The idea was then picked up by Vernon Meyer, national harvesting specialist, with the Forest Service's Northern Region. He has ordered a supply and will fill requests without charge. His address is Forest Service, USDA, Division of State and Private Forestry, Federal Building, Missoula, Montana 59807.

Mann and Lysons give directions for using their method of estimating log weight in a recent publication. Tables which relate weight to density index, scaling length, and large end diameter are included. Copies of the report, "A Method of Estimating Log Weight," by Charles N. Mann and Hilton H. Lysons, Research Paper PNW-138, are also available from Meyer or from the Pacific Northwest Station.

—By Dorothy Bergstrom,
Pacific Northwest Station

Publications



Particle board from dead timber

Results of a recent study indicate that wood from dead western white pine and lodgepole pine can be used to make various types of composition board. Researchers found that wood characteristics important in the manufacture of these materials change very little after a tree dies. In fact, trees that have been dead for many years produce particles that are as good as those from green timber. In some respects the dead material is better. These and other findings indicate that making composition board may be a practical way to use the large amounts of western white pine and lodgepole pine killed by fire, disease, and insects in the western United States.

The study was conducted by the College of Engineering at Washington State University. Three Forest Service Experiment Stations—the Pacific Northwest, Intermountain, and Rocky Mountain Stations—cooperated in the study. Wood for the study was standing dead western white pine from north Idaho and standing dead and down lodgepole pine from Wyoming. Trees ranged in condition from those that had recently died to those without needles, twigs, or small branches and with deep checks and 50 percent or more bark missing. Wood from these trees was compared with wood from green trees of both species.

The material from dead trees was more satisfactory than that from green trees in some ways. For example, there was less bark and less moisture which resulted in lower transportation and drying costs, less deterioration of stored logs and chips, and higher internal bond strength in boards made from the particles.

Material from dead trees produced about the same amount of usable fiber as that from live trees and was affected very little by decay, deep checking, and sapstain.

Particle types tested were hammer-milled, ring-cut, and drum-cut, and atmospheric- and pressure-refined. The dead material produced particles that were compatible with both urea and phenolic resins, with one exception. Drum-cut flakes of both dead and live material produced flakeboards low in internal bond strength.

Details of the study are reported in "Composition Board from Standing Dead White Pine and Dead Lodgepole Pine," by Thomas M. Maloney, John W. Talbott, M. D. Strickler, and Martin T. Lentz, from Proceedings of the Tenth Washington State University Symposium on Particleboard, March 1976. Copies of the report are available from the Pacific Northwest Station.

1978 symposium planned

The Pacific Northwest Station and Washington State University will sponsor a Symposium on "The Dead Timber

Resource" in Spokane, Washington, May 22-24, 1978. People involved in managing, selling, and utilizing dead timber will find the symposium of special interest. For further information, write or call Dick Woodfin, project leader for timber quality research at the Pacific Northwest Station; telephone 234-3361, Ext. 4966 (FTS 429-4966).

Estimating sedimentation

Information collected on the Caspar Creek Experimental Watersheds in northwestern California has been used to estimate the amounts of sediment associated with erosion-hazard ratings used in California's Coast Forest District. These ratings, which express the relative vulnerability of forested sites to erosion, are computed from information on slope, soil series (geology, soil depth, and soil texture), and precipitation. The ratings are part of the State's recently enacted laws that govern forest practices on privately owned lands, and are used in determining the type of logging operations that will be permitted.

As yet, a rating does not express a quantity of erosion or sedimentation. Researchers R.M. Rice and S.A. Sherbin of the Pacific Southwest Station, who conducted the study, believe these quantities need to be at least estimated. They contend that "only after erosion-hazard ratings have been quantified will it be possible to begin making realistic economic choices concerning the regulation of forest practices."

The Caspar Creek study site on Jackson State Forest supports forests of redwood and Douglas-fir, and is representative of the Coast Forest District—the richest timber-producing area in the State. Rice and Sherbin used data collected between 1962 and 1971 to determine the mean annual sediment production of the watersheds prior to logging and road construction. This figure, and the mean erosion hazard rating for the watersheds, became the basis for further computations. Also basic to their calculations were figures from previous studies which had shown that skyline cable yarding increases sediment by a factor of 4.6 and that tractor yarding results in 2.8 times more erosion than high-lead cable yarding. From these data, they estimated that logging operations in the Coast District may produce an estimated 17.5 cubic yards of excess sediment per acre if tractor yarding is used, or 6.3 cubic yards per acre in cable yarding operations. They say their estimates are useful as a first approximation of sediment quantities produced in logging, but suggest that further studies, covering other soil, slope, and precipitation conditions that occur within the District, are needed. Details are in Research Note PSW-323-FR14, "Estimating Sedimentation From an Erosion-Hazard Rating," by R.M. Rice and S.A. Sherbin; copies are available from the PSW Station.

Lodgepole seedling survival

A study was recently undertaken on the Bighorn National Forest, north-central Wyoming, to test the effects of water and shading treatments, and seedling size on the survival of planted lodgepole pine. Moisture stress resulting from drought has been a major factor contributing to lodgepole seedling mortality in this area.

In the study, seedlings were subjected to watering, nonwatering, shading and nonshading conditions, during dry and wet years.

Researchers found that plantations established in a dry year suffer far greater losses from water stress than those planted during wet years; and that increasing mortality will occur in subsequent years due to the aftereffects of water stress.

Losses due to severe moisture stress in dry years can be significantly reduced by shading, which creates a more favorable internal water balance by decreasing evapotranspiration. During wet years, however, shading has less affect on survival.

The study also showed that larger planting stock had a better chance of surviving, during drought, than did smaller stock. The well developed root systems of the bigger seedlings enabled them to obtain enough water to survive.

Other implications from this study can be found in "Effects of Watering, Shading, and Size of Stock on Survival of Planted Lodgepole Pine," Research Note RM-347-FR14, by Research Associate Norman Baer, South Dakota State University; Principal Silviculturist Frank Ronco, USDA Forest Service, Flagstaff, Arizona; and Professor Charles W. Barney, Colorado State University. It is available upon request from the Rocky Mountain Station.

Riparian habitat symposium

A symposium on the preservation and management of riparian habitat was held this past summer in Tucson, Arizona. The gathering, sponsored by the National Park Service and the Forest Service, stressed the continuity and interrelationships of riparian (relating to or living on the banks of a natural water course) ecosystems their wildlife and vegetation, and their historic and current uses.

Proceedings from this symposium have been published in a report titled "Importance, Preservation and Management of Riparian Habitat," General Technical Report RM-43-FR14. The report, consisting of 27 papers, highlights what is known about this unique and diminishing ecosystem. Characteristics, classification schemes, associated fauna, use conflicts, management alternatives, and research needs are all discussed in the report.

Copies of the proceedings are available upon request from the Rocky Mountain Station.

"How-To" for prescribed burning

For many managers of western forests, prescribed burning under standing timber is a new experience. Mistakes are often made during first attempts because some of the fire effects do not become apparent until days or weeks after the fire.

Ways to avoid those mistakes are described in "Preliminary Guidelines for Prescribed Burning Under Standing Timber in Western Larch/Douglas-Fir Forests," RN-INT-229, FR14, by Rodney A. Norum.

The report describes procedures for estimating and limiting the scorching of tree crowns, and provides a method to predict the percentage of litter and debris on the forest floor that will be removed by the fire.

The guidelines were developed as part of the mission of the Station's Fire in Multiple Use Management Research, Development, and Applications Program headquartered in Missoula.

Copies are available from the Intermountain Station.

Seedling moisture stress studied

Moisture stress—a measure of how much water is available to a plant—affects survival and growth of young seedlings. Research forester James L. Lindquist of the Pacific Southwest Station has completed a study of the effects of crown canopy and slope aspect on moisture stress in young Douglas-fir planted on sites in northwestern California.

Lindquist examined seedlings in clearcut and partially cut blocks on north-facing and south-facing slopes. He conducted the study during the dry summer months, when stress is the highest, and checked predawn, midmorning, and midday moisture stress levels.

He found that stress levels in the south-facing, clearcut plot became much higher earlier in the summer than stress levels in other plots; by September, however, stress levels on all plots had increased. Moisture stress apparently did not deter height growth in the south-facing, clearcut plot—the plot had the highest growth levels. However, water stress apparently affected survival—the plot was the only one in which regeneration was inadequate. On the basis of these results, Lindquist recommends partial cutting instead of clearcutting on hot, dry, slopes to lessen moisture stress (and thus increase the probability of seedling survival) by increasing shade, reducing temperatures and evaporation rates, slowing wind movement, and increasing relative humidity. The residual canopy could be provided by less desirable hardwoods or by conifers of marginal value—all of which could be removed when seedlings become well-established.

For the cooler, north-facing plots, Lindquist found that the lower plant moisture stress levels apparently did not enhance height growth. He suggests clearcutting for these sites, so that seedlings will receive maximum light and heat. This, in turn, will help ensure that growth will begin early in the summer, when moisture is available, and will continue until water stress becomes limiting—probably in September.

Further information is in the report, "Plant Moisture Stress Patterns in Planted Douglas-fir: A Preliminary Study of the Effects of Crown and Aspect," Research Note PSW-325-FR14, by James L. Lindquist. Copies are available from the PSW Station.

The Forester's Almanac

The introduction invites you to "Pick up the Almanac at coffee break if nothing better comes along or read it during staff meetings. Even if you've been in forestry for many years, you should find something new and useful."

The Forester's Almanac 1977 is a catalog of research publications from the U.S. Forest Service's Pacific Northwest Forest and Range Experiment Station. Intended primarily as a desk reference for the forest land manager, it contains brief reviews of most of the Station's

research reports for the years 1970-76, plus some older reports that are still considered especially important. The Almanac also provides information about the Station's research programs, personnel, and facilities, and includes directions for ordering publications.

The catalog is an introduction to, and a summary of, the technical literature produced through research at the PNW Station. By reading the Almanac, you can learn something about subjects as divergent as forest engineering, watershed management, silviculture, the role of mycorrhizae in forest ecosystems, and a host of other topics.

Although published for research in Oregon, Washington, and Alaska, it should also be of interest to forest land managers throughout the West—for much of the work overlaps. Forest managers, educators, students, extension specialists or anyone who wants to learn more about forestry can order *The Forester's Almanac 1977*, General Technical Report PNW-62, from the PNW Station.

Learning from the past

If you're a forest manager evaluating the influence of fire on forest ecosystems, you probably are interested in learning about the role fire has played in the past.

"A Method for Determining Fire History in Coniferous Forests of the Mountain West," GTR-INT-42, FR14, is available from the Intermountain Station.

In the publication, authors Stephen F. Arno and Kathy M. Sneck describe a method for investigating the history and ecological influences of wildfire in the inland coniferous forests of western North America.

The procedures were initially applied on study areas in the Bitterroot and Flathead National Forests of western Montana where they provided a detailed analysis of the role of fire since about the year 1600.

Dead lodgepole for powerpoles

A study has been completed in Idaho to determine if there are enough beetle-killed lodgepole pines that meet ANSI (American National Standards Institute) standards to help supply demands for powerpoles.

The mountain pine beetle has killed thousands of large lodgepole pines on the Targhee National Forest in southeastern Idaho. Forest Service Plant Pathologists Alfred C. Tegethoff, Ogden, Utah; Thomas E. Hinds, Fort Collins, Colorado; and Wallace E. Eslyn, Madison, Wisconsin, found that as long as the dead trees remained standing, many could be used for poles and other wood products.

The 1972 ANSI standard for wood poles does not require that they be cut from living trees, but they must be free from decay and meet other specifications. About 38 percent of the dead lodgepole pines examined in this study met ANSI pole standards.

The report describing this research, titled "Beetle-Killed Lodgepole Pines are Suitable for Powerpoles," is a reprint from the Forest Products Journal, Vol. 27, No. 9. It states that "utilization of these trees should help to ease the current pole shortage."

If you would like a copy of the reprint describing this study, write to the Rocky Mountain Station.

Herbicide does not persist long

The herbicide 2, 4, 5-T disappeared rapidly from forest vegetation and soil and did not present a significant threat to wildlife or soil microorganisms. These were the major findings from a study conducted near Vernonia, Oregon, to find out how long 2, 4, 5-T residues persist in the forest environment. The herbicide is widely used to control the growth of plant species that compete with conifers on many acres of forest land in the Pacific Northwest.

Research Chemist Logan Norris of the Pacific Northwest Station directed a study in cooperation with M. L. Montgomery and E. R. Johnson of the Department of Agricultural Chemistry at Oregon State University. The study was conducted on approximately 87 hectares of typical Douglas-fir forest, sprayed by helicopter with 2.24 kilograms of 2,4,5-T per hectare. A second application was made to 6 of the 9 original plots one year later. The persistence of the herbicide was measured in four kinds of vegetation (grasses, vine maple, blackberry and Douglas-fir), in the forest floor, and in the soil.

There was a marked difference in herbicide concentration in the four species of vegetation after both applications. Initial concentrations ranged from 165 ppmw (parts per million by weight) in blackberry leaves to 23 ppmw in vine maple buds and leaves. Residues declined in different species at different rates, but most rapidly and completely in blackberry. Concentrations in all vegetation dropped sharply during the first 3 months, and after one year ranged from 0.48 ppmw in vine maple to 0.03 ppmw in blackberry. Only vine maple contained detectable (0.02 ppmw) residue after 24 months. In the forest floor, residues of 2,4,5-T increased slightly during the first month after application and then declined sharply. After one year, residue levels were about 0.017 kilogram per hectare, or 0.0076 of the amount originally applied.

In the soil, residue levels were low compared with those in the forest floor and declined 90 percent during the first 6 months. After 6 months, less than 0.02 kilograms per hectare remained. No residues were found deeper than 15 centimeters.

The presence of TCDD (dioxin) as a contaminant of 2,4,5-T is a central issue in the controversy about possible hazards resulting from the use of 2,4,5-T. The chemists were not equipped to measure TCDD levels in this study; so they calculated the amount of TCDD in the vegetation, forest floor, and soil immediately after application of the herbicide. These calculations were based on the initial levels of 2,4,5-T and the known ratio of TCDD to 2,4,5-T (1 part TCDD to 10 million parts 2,4,5-T). The calculated levels were below the no-effect level for TCDD established from a 13-week feeding study with laboratory animals. Based on the 2,4,5-T levels reported in this study, the caluclated TCDD levels, and the toxicology of these compounds, the authors concluded there is very little chance of a toxic impact from either TCDD or 2,4,5-T applied to this forest land.

Copies of the report, "The Persistence of 2,4,5-T in a Pacific Northwest Forest" by L. A. Norris, M. L. Montgomery and E. R. Johnson, reprinted from Weed Science 25:417-422 (September 1977) are available from the Pacific Northwest Station.

Evaluation results help

Several years ago, as *Forestry Research: What's New in the West* was just getting off the ground, it was decided to periodically evaluate the publication, and make changes to improve its usefulness to the readers — the managers of our natural resources.

In cooperation with Richard Shikiar and Jacob Hautaluoma, Associate Professors of Psychology at Colorado State University, we undertook the first evaluation, covering five issues.

The evaluation was directed toward Forest Service practitioners, since they comprised the largest reader audience at the time. Survey participants were asked specific questions about writing style, number of articles, subject matter, article and publication length, timeliness of information, and whether or not the publication duplicated other information efforts. They were also asked which articles they found most useful, how they intended to use the information, and to make suggestions for improving the usefulness of the publication.

Respondents made a number of suggestions for improvements. Many have since been incorporated into the publication, such as: a table of contents, more bibliographic information, more frequent distribution, less costly paper, article consolidation, and more graphics. Respondents generally agreed that articles were well written, understandable, timely, and about right in length, number, and subject variety. Eighty-five percent of the respondents said they found useful information in the publication.

We, the Staff of Forestry Research, felt the evaluation helped us assess the worth of the publication, especially in its early stages, and showed us where improvements were needed. Additional evaluations are planned so that we can further improve the publication.

Thanks to many of you for helping us with the first evaluation. We invite your continuing comments on how we can make Forestry Research more meaningful and useful to you. Address them to the Rocky Mountain Station in Fort Collins, Colorado.

Don't miss the next issue of Forestry Research. It will feature stories on the Shrub Sciences Laboratory at Provo, Utah; the introduction of predators to control forest insect pests; and gully control programs; and much more.

If you know of someone who would be interested in this publication, he or she can be added to the mailing list by filling out the coupon below and mailing it to us.

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